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Tuberculosis of Bones and Joints.

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TUBERCULOSIS OF BONES AND JOINTS.

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History.—The tuberculosis of bones and joints form anatomically and clinically a unit, because the tuberculosis of the bones usually extends to the joints, and derives from the affections of the latter the main clinical features.

Our knowledge of this branch of tuberculosis is only twenty years old, commencing at the time when Karl Küster called attention to the frequent occurrence of miliary tubercles in the fungous granulations of the disease then known as white swelling. Soon afterwards Friedländer, Hueter, and especially Volkmann and König, not only verified Küster's statements, but carefully studied anatomically, clinically and experimentally this form of local tuberculosis. This naturally attracted the universal attention of the profession, so that an extensive literature of the subject quickly sprang up—so quickly, indeed, that even before Koch's discovery of the bacillus tuberculosis, in 1881, the tuberculosis of bones and joints was already well established as a distinct form of disease. So much was this the case that Volkmann, at the German Surgical Congress in 1885, was able to state that all cases of the hitherto so-called paidarthrocacis, spina-ventosa, tumor albus, fungous and strumous arthritis, etc., belonged to tuberculosis.

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Etiology.—Tuberculosis of bones and joints is evidently always a secondary invasion; that is, the place of primary invasion of the bacillus must be elsewhere in the body, and one or more depôts must exist in the lungs or lymph glands before so deep-seated localities as the bones and joints can be invaded. When, therefore, authors speak of primary tuberculosis of the bones and joints, it is only a clinical term and means that clinical examination, or even the autopsy, fails to reveal the place of invasion, the primary depôts. As a clinical distinction its importance lies in the fact that if tuberculosis is practically localized to a joint, the patient's life is not in danger from deposits in other organs, and the total removal might prove efficient to extinguish the disease.

In this sense a primary, or, to use the more correct expression, a localized articular and osseous tuberculosis, is, according to Kümmer, found in about 40 per cent. of the cases. In the remaining 60 per cent., depôts are found at the same time in other organs of the body. The lungs come first with 25 per cent.; other joints, 10 per cent.; bones, 10 per cent.; glands, 10 per cent.; peritoneum, 3 per cent.; pleura, 2 per cent.

The presence of the bacillus of tuberculosis in a body is the *condition sine qua non*, and may be aided by other etiological elements, the most important of which is traumatism. Max Schüller proved experimentally in animals infected with tuberculosis (for instance through the respiratory tract) that a slight traumatism to a joint would determine the localization of the bacillus tuberculosis, by way of the circulation, to the place of traumatism, and that a tuberculous synovitis or panarthrititis would follow.

Clinically the tuberculosis of joints has been traced in 56 per cent. of the cases to traumatism,

by a direct blow to a joint, or distortion, or over-exertion. It is characteristic that the traumatism is always slight; a severe trauma, causing intra-articular fracture, is very rarely followed by tuberculosis.

As a general characteristic of the articular and osseous tuberculosis it must be stated that it belongs to the benignant chronic forms of disease; that is, it lasts for years and years, has a tendency to spontaneous recovery, little tendency to generalization and, consequently, to the destruction of life, as compared with the acute forms of tuberculosis of the internal organs, or even the experimental inoculated tuberculosis.

An explanation of this clinical fact is given by Baumgarten, who distinguishes between three forms of miliary tubercles:

1. The lymphoid-celled tubercle, Virchow's small-celled tubercle, which is rich in bacilli, extremely malignant, and is found in tuberculosis miliaris acutissima, for instance in the lungs.

2. The mixed tubercle of lymphoid cells and epithelioid cells, which contains fewer bacilli, is less benignant, and is found in the more chronic forms of general miliary tuberculosis.

3. The epithelioid and giant-celled tubercle, with no lymphoid cells, containing comparatively few bacilli, more benignant, and found in the benign forms of localized tuberculosis, joints, bones, lupus and lymph glands.

That this benignancy of the tubercle can be dependent upon lessened vitality in the tubercle bacillus has been proven experimentally by the inoculation of artificially weakened cultures, which were seen to produce localized tuberculosis in the nearest lymph glands only, with no generalization (Baumgarten). Kümmer found heredity as an element in 37 per cent. of the cases.

Anatomy.—Tuberculosis has a distinct predilection for the medullary tissue of the bones; thus it is correct to speak of the tuberculous osteo-myelitis as a first effect of the arrest of bacilli in some place of the medulla. The anatomical condition of the vessels in this tissue, thin walls, slight contractility and sluggish circulation, favor the implantation on the vessel wall, in the same way as pus microbes are localized in acute osteo-myelitis.

Embolism from foci in the lungs opening into the pulmonary veins may cause a tuberculous infarction of the bone. The interesting experiments of Müller, who injected pus from a tuberculous abscess into the nutrient artery of the long bones of goats and rabbits, have proven that this is a possible origin of local osteo-tuberculosis.

The seat of the tuberculosis in bones is usually in the cancellous substance of the epiphysis of the long bones, the short and flat bones, and very seldom, the medulla of the shafts. The only exceptions to this are the shafts of the phalanges of the fingers and toes, and the metacarpal and metatarsal bones in children, where the tuberculous osteo-myelitis gives rise to the well-known spina-ventosa of the old authors.

The frequency of the localization in the different bones of the body is given by Schmallfuss, as follows:

Billroth.	Jaffe.	Per cent.	Schmallfuss.	Per cent.
Vertebra	Vertebra	26	Knee	23
Knee	Foot	21	Foot	19
Cranium	Hip	13	Hip	16
Face	Knee	10	Elbow	9
Hip	Hand	9	Hand	8
Sternum-Ribs	Elbow	4	Vertebra	7.5
Foot	Pelvis	3	Tibia	4
Elbow	Cranium	3	Cranium	4
Pelvis			Pelvis	3.6
Tibia and Fibula	Sternum, Clavicle and Ribs	3	Sternum, etc.	3.6
Femur	Shoulder	2	Femur	1.9
Shoulder	Femur	1	Shoulder	1.5
Humerus	Tibia	1	Ulna	1.4
Ulna	Fibula	1	Humerus	1
Radius	Humerus	1	Radius	0.7
Scapula	Scapula	0.6	Fibula	0.5
	Ulna	0.6	Patella	0.1

The gross appearances of the osteo-tuberculosis as it is found in the articular extremities of the long bones are well described by König under the three following forms: (1) The granulating focus; (2) the tubercular necrosis, and (3) the tuberculous infarct, the diffuse tuberculous osteomyelitis.

1. *The granulating focus* is found as single or multiple, round or cylindrical cavities, from the size of a millet seed to that of a pea or hazelnut, and contains either grayish-red, soft, living granulation tissue, or, if coagulation necrosis has taken place, yellowish-gray cheesy matter or liquid tuberculous pus. Fine spicula of bone may be felt with the finger, or when smaller, seen with the microscope in the contents.

The granulation tissue contains epithelioid and giant-celled tubercles and bacilli. The wall of the cavity is either soft, when rarefying osteomyelitis has taken place, significant of destruction and extension; or sclerotic when an osteo-plastic osteomyelitis surrounds the focus, showing a tendency to localization and cicatrization. As

little as this form of osteo-myelitis has in common with the usual form of acute osteo-myelitis due to pus microbes, with its extensive area of inflammation and large sequestra, still it may be difficult to distinguish it from the more rare form of sub-acute multiple osteo-myelitis of the epiphysis, in which multiple foci of similar form are found. But the infectious osteo-myelitis has thin yellow pus and flabby granulations without tubercles, and the pus contains pus microbes.

2. *The tubercular necrosis.* When the area of the tuberculous osteo-myelitis is larger than a hazelnut, the bone is usually not absorbed, but remains as a sequestrum in the cavity. This sequestrum is sometimes osteo-sclerotic, sometimes osteo-porotic, sometimes like the surrounding bone, according to the character of the osteo-myelitis previous to the interruption of nutrition. It is yellowish-white or grayish-red, according to the contents of the Haversian canals or medullary spaces of dead or living tuberculous tissue. It may be separated from the wall of the cavity by a layer of tuberculous granulation tissue, or dry cheesy matter, or tuberculous pus. If separated by a layer of granulation tissue, this may be so thin that the sequestrum fits the cavity exactly, and, if its shape is irregular, fits in so immovably that it takes a good deal of force to pry it out by the gouge and chisel.

3. *The tuberculous infarct* has the characteristic conical shape of infarcts in other parts of the body, with the apex in a proximal and the base in a distal direction. It represents the territory of an artery and suggests embolism. Large infarcts, then, must require either a larger embolus, or, in addition to the embolus, arterial thrombosis, from the place of arrest of the embolus. Their seat is usually a little inside of the cortical

substance of the bone ; thus, they may be overlooked if the bone is not sawn through. If, as in the specimen here presented, the base takes in the articular surface of the joint, this surface will be ground off and polished, signifying instantaneous death of the infarct at the time of the embolism.

The line of demarcation forms slowly as a furrow surrounding the dead area, the central portion of which may remain in connection with the living bone for a long time, a year or more, even in a joint apparently on the way to recovery.

The smallest sequestra, in the dry forms of tuberculosis with a tendency to cicatrization, may heal in or be imbedded in the non-tuberculous cicatricial tissue, remaining after the tuberculosis has come to an end and incomplete recovery taken place, without perceptibly disturbing the function.

The fate of the osteo-tuberculous foci varies according to the activity of the microbe and the size of the focus. The smaller granulation foci in the dry forms of tuberculosis may result in either complete recovery by removal of the tuberculous elements by absorption and filling up the cavity with cicatricial tissue, or in incomplete recovery, in which part of the focus is transformed into cicatricial tissue, in part of which dormant bacilli remain. These are apt to be revived under favorable circumstances, of which a fresh culture fluid from a traumatism is the only one known. In the joints, however, this is a very common occurrence, as we shall see later on. This accounts for the local relapses so frequent in tuberculosis as to make a permanent recovery almost impossible.

Small sequestra may, as stated above, disappear by absorption, or be included in the cicatricial tissue. Large sequestra will, of course,

neither be absorbed nor be included in a cicatrix. Moreover, they furnish an inexhaustible depôt of bacilli and keep up the local tuberculosis on its progressive way to further destruction.

We have hitherto considered the osteo-tuberculosis at its place of origin in the bone, where it is of comparatively little importance, since so long as it is confined to the bone it gives rise to little or no functional disturbance. We shall now follow it on its extension beyond the bone, and then distinguish between its extension to the periosteum and the soft tissues on the one hand, and to the joints on the other. It is not until the tuberculosis has extended to one of the places named, that its symptoms become manifest and the grave consequences to the patient's welfare take place.

1. Extension to the periosteum outside of the joints.—It is characteristic of tuberculosis that the periosteum, on the whole, is rarely affected to any great extent. We do not find, as in acute osteo-myelitis, a diffuse infiltration of the periosteum and the formation of extensive masses of bone. Tuberculosis of the periosteum is localized in the joint in the same way as in tubercular osteo-myelitis, and the place of perforation limited to a small area surrounded by normal periosteum, with little or no thickening or enlargement of the bone affected. When the dry granulating form of tuberculosis reaches the periosteum a small, soft, elastic, limited granulation tumor forms, first under the periosteum, then outside of it. It is characterized by slow growth, comparatively little pain, slight tenderness, and a tendency to remain stationary for a long time. It is different with the soft suppurating tuberculosis, which, although it also breaks through the periosteum in a limited space, acts in an entirely dif-

ferent way as soon as it has reached the para-periosteal loose, connective-tissue spaces. Here it has a tendency to extend rapidly and to form large abscesses, the so-called cold abscesses, traveling, like all other abscesses in connective tissues, in the direction of least resistance. On its way from the deep para-periosteal tissues out toward the skin, it forms large or small abscess cavities and finally breaks through to the surface, after having transformed the skin into tuberculous tissue, which sometimes presents the appearance of lupus at the place of perforation. No conclusion can be drawn from the size or acuteness of the abscess as to the extent of the osteo-tuberculosis. A large abscess may come from a small focus in the bone, and *vice versa*.

The question has arisen whether the rapid formation of tuberculous abscesses is not the consequence of a mixed infection from auto-infection of pus microbes. It must be said that such auto-infection is rare, as the pus in these abscesses is found on microscopical examination and culture in culture substances, not only not to contain pus microbes, but its inoculation in the camera anterior of the eye, or the abdominal cavity of animals, produces an unmixed tuberculous invasion and no suppuration.

Diffuse tuberculous osteo-myelitis.—This form is rare. On the cut surface of the bone we find large, irregular, often multiple areas and islands, with no tendency to definition, of a yellowish-white infiltration, containing small multiple foci of liquid pus. Here is no tendency to limitation or the formation of sequestra, but rather a tendency to spread indefinitely and to invade even the medullary tissue of the shafts. This form has in common with the acute diffuse osteo-myelitis that it will spread through the Haversian

canals diffusely to the periosteum and cause a diffuse plastic periostitis with irregular diffuse masses of bone formed on the outside of the cortical substance. Consequently it resembles, in its clinical features, acute osteo-myelitis. Locally and generally it is a severe form: locally it forms an extensive tuberculous depôt, from which abscesses may form indefinitely; generally, patients with this form are exposed to the dangers of a fatal general tuberculosis if the whole depôt is not removed in time. In operating it is important to recognize this form, since it requires more radical measures, either amputation or very extensive excision. As a rule, the mere removal of the periosteal tuberculous masses and the diseased medullary tissue is insufficient, and the whole continuity of the bone must be taken away, as in the specimen here presented. Fortunately this form is extremely rare.

Tuberculous abscess.—In addition to what has already been stated about the tuberculous abscess I shall here briefly call attention to the main characteristics of its wall, which is formed of a thinner or thicker layer of tuberculous granulation tissue thickly studded with the characteristic miliary tubercles of the benignant type, with relatively few bacilli. This tuberculous pyogenic membrane, as it was called by the old authors, is only very loosely connected with the surrounding tissues and organs, in the spaces between which it is located. So loose is the connection that, when the abscess is opened, the whole membrane can be wiped off the wall with a sponge, or, when more firmly attached, easily removed with a sharp spoon, leaving the walls so healthy as to readily unite by first intention when brought together; hence the modern treatment of these abscesses by incision of the whole

length, removal of the wall, and reunion. In rare instances, however, a fascia, for instance the fascia lata of the femur, may be diffusely infiltrated, even to such a degree as to cause diffuse necrosis, presenting the appearance of diffuse phlegmonous inflammation. In such cases careful removal, by the knife and scissors, of the whole area involved is required.

At this place I will call attention to the latest step in the conservative treatment of large tuberculous abscesses, especially the large psoas abscesses from tuberculosis of the vertebral column from Pott's disease. It is well known that the opening of these abscesses in præ-antiseptic times was almost always followed by a fatal septic infection from without. The modern opening and drainage under antiseptic precautions, so much praised in the beginning, has been proven not to be without danger, inasmuch as, in many cases, late infection has taken place when, after months, the inclosed fistulous openings have been guarded with less stringency in the application of antiseptic dressings.

Thus, two years ago, Bruns, in Tübingen, proposed a return to the older subcutaneous method, namely aspiration; but, in addition to this, injection into the emptied abscess cavity of a 10 per cent. iodoform emulsion in equal parts of glycerine and alcohol, this procedure to be repeated every four to six weeks. Usually, after three or four aspirations, the formation of pus in the abscess cavity ceases, the fever stops, and the patient regains health and strength. No iodoform poisoning from this treatment has yet been reported.

2. *Extension into the joints.*—The osteo-tuberculous foci in the epiphyses of the long bones are situated so near to the surface of the joint that,

when they come to the surface, in an overwhelming majority of the cases, they will be inside of the articular cavity; the bacilli of tuberculosis are consequently poured into the joint, and a tuberculous synovitis or arthritis is the result.

Tuberculosis of joints is by far the most common joint disease, so much so that König states that, in the surgical clinics, the surgeon will have 100 cases of tuberculosis of the joints to deal with to one of the other classes of inflammation, such as gonorrhœal, syphilitic, septic, osteomyelitic, rheumatic, or the metastatic inflammations subsequent to acute infectious disease. Although the statement may seem to the general practitioner to be carried to the extreme, still the authority of König is sufficient warrant for the statement that tuberculosis as a cause of joint disease far exceeds all others, and that the tubercular arthritides are the everyday cases of the surgeon.

We distinguish, as to origin, between primary synovial and primary osteal tuberculosis of the joints. Max Schüller stated, as a result of experiments, that a slight injury to a joint in a person who had bacilli floating in his blood would determine localization, commonly in the form of a synovial tuberculosis. It may be said here that, as to the relative frequency of the two forms, it has been shown that the primary osteal tuberculosis occurs two or three times as often as the primary synovial. As far as the course and development of the articular tuberculosis is concerned, the difference in origin makes little or no difference—so little, indeed, that we are unable to make a differential diagnosis, even from the symptoms.

As to the primary osteal tuberculosis of the joints, we have already seen that an osteo-tuber-

culous infarct is located in the joint from its very beginning, while the smaller granulation foci open into the joint secondarily. When located close to the articular cartilage, this must be destroyed before the joint is invaded, the cartilage forming a barrier which may sometimes prove sufficient to resist invasion. A small dry granulation focus may heal up before perforation takes place.

When located at the surface of the joint, where the bone is not covered with articular cartilage, the thin periosteum and the serous membrane covering it are more easily opened through. An important complication is when an osteo-tuberculous focus is placed right at the insertion of the capsule of the joint. It may then open in and outside of the joint simultaneously, or the one or the other, the saving of the joint depending upon the few lines of difference. When the tubercle bacillus invades a joint and tuberculosis of the joint ensues, all the constituent parts of the joint will be successively affected, namely, the synovial membrane, para-synovial tissue, ligaments and peri-synovial tissues, the articular cartilage, and finally the articular surface of the bone.

It is a question whether so light a form of inflammation as a simple synovitis (whatever that may be), as mentioned by Kümmer, can set in as an effect of either ptomaines alone, from a near focus, or from extremely weakened tubercle bacilli. A simple serous synovitis of entirely benignant character, if it exist, is of extremely rare occurrence.

Commonly the presence of the tubercle bacillus in the joint produces one of the following forms :
 1. A pannous hyperplastic synovitis. 2. A tuberculous hyperplastic synovitis or papillamatus

plastic synovitis. 3. A granular or fungous hyperplastic synovitis (Hueter); and, 4. The tuberculous articular empyema (König).

1. *The pannous hyperplastic synovitis (Hueter).*—The synovial membrane is moderately thickened. From the border of the cartilage a thin vascular layer of granulation tissue creeps in over the surface of the latter, so much so as to sometimes cover the larger part of the surface and unite with the cartilage, which gradually becomes transformed into connective tissue. The tubercles are usually not visible to the naked eye.

2. *The tuberos plastic synovitis, or circumscribed nodular tuberculosis of the synovial membrane.*—The tubercular fibroma is characterized by the development of a subserous tumor the size of a walnut or larger, protruding into the joint and filling, for example, the supra-patellar recess of the knee-joint, with simple synovitis or pannous synovitis in the rest of the cavity. Such a local tuberculosis is amenable to extirpation of the tuberculous tumor followed by recovery. The papillomatous plastic synovitis is a diffuse form of hyperplastic tuberculosis, and, as shown in the specimen, we find the whole inner surface of the synovial membrane covered with sessile or pedunculated papillomatous growths, small and rather uniform in size, some of which may become detached and constitute the so-called rice bodies.

3. *Diffuse granulating synovial tuberculosis.*—Here the synovial membrane is considerably thickened, hyperæmic, with or without visible tubercles, always accompanied by invasion of the para-articular tissue and the ligaments of the joint. Thus is formed the thick œdematous mass of tissue, usually of a gelatinous appearance, in which coagulation necrosis will cause, in the

more dry forms, islands of cheesy matter ; in the more liquid forms, islands of pus, that is, small multiple abscesses.

Any of the above named forms of synovitis may give rise to the exudation of serous or sero-fibrinous fluid in the joint, the tuberculous hydrops of König. A considerable hydrops is most commonly associated with a diffuse synovial tuberculosis, with little thickening of the capsule. Less commonly it is found in the tuberous and papillomatous synovitis ; most rarely in the fungous or granulating synovitis. The fluid is clear in the lighter forms ; slightly milky from migratory corpuscles, or mixed with shreds of fibrin in the severer forms. So-called rice corpuscles may be found and derived either from islands of fibrin or from loosened papillomata. Their presence indicates tuberculosis (Reidel).

4. *Empyema articulationis tuberculosum*. Cold abscess of the joint (König).—The inside of the capsule is covered with loosely adherent tuberculous membrane similar to that in tuberculous abscesses, so loosely connected with the capsule as to permit of its being scraped off. The remaining synovial membrane is diffusely infiltrated with miliary tubercles, but only slightly thickened, if at all, because of the non-invasion of the para-synovial tissues.

The articular cartilage plays, as a rule, only a passive part in tuberculosis of the joint, as its fate is destruction or absorption. The cartilage covering a large sequestrum dies off and is mechanically detached from the bone in smaller or larger pieces. An osteo tuberculous focus, when reaching the cartilage, will cause gradual local absorption, and a local, usually round defect, through which red granulation tissue or cheesy matter protrudes. The surrounding cartilage

may be entirely normal and efficient for the function of the joint. A primary synovial tuberculosis has a tendency to develop most intensely in the region of the capsule at the circumference of the articular cartilage. From here it has an easier way down into the vascular bone than into the non-vascular cartilage, and extends down between the bone and the cartilage as a tuberculous osteo-myelitis, creating a layer of tuberculous granulation tissue that will detach the cartilage from the bone. Local hyperplastic foci in this granulation tissue may perforate the cartilage in many places, just the same as a primary osteo-tuberculous focus, so that the cartilage presents the appearance of a sieve. Finally either the whole cartilage or shreds of it are found loose in the cavity of the joint.

In the pannous synovitis and the dry forms of fungous synovitis an apparently direct transformation of cartilage into connective tissue takes place.

The articular surfaces of the bone, after the disappearance of the cartilage, present the following appearance: In the dry form, a layer of not very vascular connective tissue covers the surface and connects it with the opposite similarly transformed surface. In the more moist and suppurating forms, a layer of miliary tuberculous tissue covers the bone with visible, yellow miliary tubercles, extending usually only a short distance down from the surface. Thus the whole head of the femur, the acetabulum, etc., is gradually destroyed.

SYMPTOMS.

I. *Tuberculous Hydrops*, as we have stated, is common in the diffuse synovial tuberculosis with little swelling of the capsule, also in the papillo-

matous diffuse synovitis or local tuberous synovitis, but is seldom found in the granulating fungous synovitis. It is characterized by the usual symptoms of a painless intra-articular accumulation of fluid which usually reaccumulates when removed, and sooner or later, the tuberculosis going on, shows some thickening of the capsule after removal of the fluid.

The prognosis is relatively good because there is little tendency to destruction of the joint or to suppuration. Some cases recover after puncture and rest. Rice bodies, when present, can be felt to give a peculiar friction sound when moved from one point of the joint to another. The joint remains for a long time in relatively good function which only ceases when, later on, thickening of the capsule and destruction of the joint sets in. A tubercular fibroma can be felt after the aspiration of the joint as a sessile, more or less movable tumor, simulating floating cartilage. Simple arthrotomy and extirpation may prove effectual. The tuberculous hydrops is never accompanied by fever. As above stated, the lighter forms may recover by aspiration and immobilization. More obstinate forms require opening of the joint, excision of the local tumors if found, a partial excision of portions of the capsule with iodoformization and drainage. König has opened the knee-joint on both sides of the patella, excised large slices of the capsule, and seen perfect recovery. However, the result is always uncertain, and the tuberculosis may in spite of initial, more conservative treatment, go on to the severe and more destructive forms, and require more radical operative measures.

II. *Fungous Arthritis, Granulating Synovial Tuberculosis, White Swelling, Tumor Albus.* This is by far the most common form of tuberculosis

of the joints, whether primary osteal or primary synovial. No symptoms enable us to make a distinct diagnosis between a primary osteal and a primary synovial tuberculosis of the joint, but as we stated in the discussion of tuberculosis of the bones, the primary osteal form is the most common. In the knee, the proportion of the primary osteal to the primary synovial form is as three to one; in the hip, four to one; in the elbow, four to one (König). As to age, the proportion is in children below 15, two to one; above 15, three to one. If it were possible to know that a large osteo-tuberculous focus was to be found in a given case of articular tuberculosis, this knowledge would determine an immediate operation, and no time would be lost by conservative treatment. But unfortunately, as yet the diagnosis is almost impossible.

The fungous arthritis is much more more frequent in the lower than in the upper extremities. According to Albrecht, out of 325 cases, of which he gives the statistics, 91 were found in the joints of the upper extremity, and 234 in those of the lower extremity. The granulating synovitis or fungous arthritis presents a great variety of clinical forms, according to the acuteness of the onset and the course; slowness or rapidity of destruction, and extent of the infiltration of the synovial tissues. It is especially the degree of peri-articular infiltration, its almost entire absence, or presence, in abundance, that makes the clinical distinction between the dry and soft forms so characteristic that Volkmann has called attention to the former as a distinct class of cases.

1. *The dry granulating tuberculosis, the atrophic form, plastic synovitis* (Kümmer), *caries sicca* of Volkmann, so common in the shoulder-

joint is characterized by the tendency of the tuberculous tissue to cicatrization, and slight tendency to extensive destruction of cartilage and bone. Absence of invasion of para-articular tissues results in only a slight or in no swelling in the region of the joint, which may even be found atrophic, as in the shoulder-joint from atrophy of the muscles, or in the hip-joint in young individuals (König); more rarely in the knee. In the shoulder-joint there may be considerable atrophy, and still so much mobility that the disease may simulate a neurosis resulting in atrophy of the muscles of the joint. A careful examination *in narcosis*, revealing restriction of mobility from cicatricial contraction of the tuberculous capsule, will enable us to make an early diagnosis, which is confirmed later on when peri-articular abscesses form. In a majority of cases, however, this form has a tendency to come to an end without the formation of abscesses, terminating simply in a more or less restricted mobility of the joint. Dry caries of the shoulder-joint is found not infrequently in young women (König).

2. *Fungous arthritis, tumor albus, synovitis fungosa sive granulosa*, is probably the most common of all the forms of articular tuberculosis. It is characterized by the softer condition of the tuberculous granulation tissue, with tendency to destructive invasion of all the elements of the joint, coagulation necrosis and liquefaction. The invasion of the para-articular tissues causes considerable swelling in the region of the joint, giving to the latter the characteristic spindle-shape so frequently found in the knee, elbow and ankle-joints; the swelling being so much the more apparent when atrophy of the muscles above and below has taken place. Extension of the infiltration

from the para-articular tissues out towards the subcutaneous tissues finally causes the swollen joint to be covered with a whitish, immovable, dense skin, giving the joint the appearance from which the time-honored name of white swelling is derived. In the beginning of the disease a slight degree of hydrops is found in a few cases; most often the cavity of the joint contains no fluid, or not a sufficient amount to be recognized by palpation. Later in the disease liquefaction in the islands of coagulation necrosis in the islands of soft granulation tissue gives rise to the presence of tuberculous pus. This may be found as small foci in the soft granulating capsule, small abscesses inside of the granulation tissue, or as pus from the cavity of the joint. At this stage of the disease, especially in the softer form of tuberculosis, the peri-articular abscess is formed. Most commonly a local destruction of the tuberculous capsule facilitates the invasion of the peri-articular inter-muscular spaces by the tuberculous pus already contained in the joint; and a more or less rapid increase in size of the abscess cavity in the direction of least resistance, causes the formation of more or less distant abscess cavities, which of course, always lead into the cavity of the joint. More rarely, peri-articular abscesses form directly from an osteal focus by the extension of a mass of tuberculous granulation tissue, extending through the capsule out into the peri-articular tissue, as a primary mass of solid granulation tissue in which liquefaction takes place secondarily. A peri-articular abscess originating in this way may attain the same size as that previously mentioned, but owing to its original form a local osteo-tuberculous focus is of less prognostic importance, inasmuch as it does not necessarily indicate suppurative destruction

of the cavity of the joint. This latter form of abscess may be opened and evacuated and may then close up with or without the removal of the osteo-tuberculous focus and still leave the joint in a more or less unimpaired condition; while on the other hand, the peri-articular abscess communicating directly with the destroyed joint cavity has no tendency to come to a close, but leaves fistulous openings which keep open permanently, and only too often, when not protected by antiseptic dressings, sooner or later, furnish a place of invasion for pus microbes, adding acute sup-puration or sepsis to the tuberculosis, and giving rise to a rapid increase in the destruction of the articular surface.

A fungous arthritis, when limited to a single joint, will rarely cause any rise in temperature. High temperature is always indicative of a mixed infection with pus microbes, or what is very rarely met with, general acute tuberculosis. By far the most common is the mixed infection which comes from without, the pus microbes entering the open and unprotected peri-articular abscess. It is very exceptional that auto-infection, that is, invasion of a closed tuberculous joint by floating pus microbes from a distant place of invasion, takes place. A slight rise in temperature, remittent or intermittent, however, commonly accompanies the formation of tubercular peri-articular abscesses. A temperature of 100° to 101° in the evening with normal morning temperature is indicative of this complication, and this, as first pointed out by König, is an important diagnostic symptom.

Contractions, lateral deviations or other abnormal positions of the articular surfaces, usually signify destruction of the articular ligaments and articular surfaces. They are thus not seen in the articular hydrops, or the lighter forms of syno-

vial tuberculosis, while we find them in tumor albus, or the destructive forms of para-arthritis. König very properly uses the term "destructions-contractur" (contraction by destruction), for these displacements, in preference to the usual term of spontaneous dislocations, and employs the latter expression to signify the condition when through muscular contraction or a slight injury to the joint, whose strengthening ligaments are destroyed, a sudden, very painful and often considerable displacement takes place. This is especially common in the hip-joint. The clinical importance of any of these displacements lies in the fact that they signify a certain amount of destruction of the joint, thus often indicating surgical interference.

Pain as a symptom accompanying tuberculosis of the joint, although always present, is of extremely variable intensity ; two patients with an apparently similar degree or form of tuberculosis in the knee-joint may differ so much as far as pain is concerned that the one may be able to walk almost without pain, while in the other, the slightest movement will cause intense suffering. Although the intensity of the pain does not give any absolutely certain information as to the extent of destruction of the joint, it may be said that in general, the more acute destructive forms of tuberculosis are the more painful, and further, that intense pain on movement may mean large intra-articular osteal foci, and extensive intra-articular destruction ; while slight pain would indicate that the articular cartilage was as yet comparatively intact. A sudden attack of intense pain sometimes means that perforation of an osteal focus into the yet intact joint cavity has taken place. It is of more practical importance when we find a local painful spot on the articular ex-

tremity of the bone, especially when it is outside of the usual line of the swollen and tender capsule. Inasmuch as this may indicate an osteal focus if the tender spot shows some localized softness or swelling, it is of even more significance in this direction, and indicates a local operation which may save an as yet comparatively intact joint.

3. *Cold Abscess, the Pyarthrous Tuberculosis*, is rare. Its most typical form is found in diffuse miliary tuberculosis, and a less typical form, that is, less fluid in the joint, in the soft forms of granulating tuberculosis. The onset is usually acute, often with considerable pain accompanied by fever, so as even to simulate suppurative synovitis. There is a tendency to destruction of the capsule and the early formation of large peri-articular and inter-muscular abscesses. The symptoms of general acute tuberculosis are likely to set in sooner or later.

DIAGNOSIS.

As a rule there is no difficulty in the diagnosis of tuberculosis of the joints when the history, course and symptoms of the disease are taken into consideration, as above stated; but, as König justly remarks, it is well to remember that an articular tuberculosis even of the large joints, is practically a local disease, and has for a long time little or no influence on the general health of the patient. Thus we may find patients apparently strong and healthy-looking sufferin from articular tuberculosis.

The hydrops tuberculosis is distinguished from a "common articular hydrops," whatever that may mean, traumatic, for instance, by its persistency and tendency to relapse as soon as the

joint is put to use again. Flocculi of fibrin or rice bodies indicate tuberculosis.

The tubercular fibromas might be mistaken for lipoma arborescens or gummata. The diagnosis of the latter will be cleared up by anti-specific treatment, which should always be tried in cases of doubt.

Cold abscess is distinguished from the suppurating synovitis by less pain, some swelling of the capsule, and the frequent presence of tuberculosis in other organs.

The fungous synovitis or pan-arthritis rarely causes any difficulties in diagnosis. The elastic swelling, comparatively painless abscesses or fistulous openings with fungous granulation tissue protruding are characteristic. It can be distinguished from acute multiple osteo-myelitis of the articular surfaces by its slow and comparatively painless onset, and the slight tendency to ankylosis as compared with the latter.

The caries sicca of Volkmann, or dry cicatricial atrophic tuberculosis, especially as found in the shoulder-joint, might be mistaken for a neurosis with atrophy of the muscles covering the joint. An examination *in narcosis* will reveal some loss of mobility in the tuberculosis as compared with the absolutely free mobility in neurosis. Exact measurement may reveal some shortening, that is, articular destruction in the tuberculosis.

PROGNOSIS.

It is almost impossible in any given case of articular tuberculosis to state the future fate of the joint, inasmuch as the course of the tuberculosis is in the highest degree atypical. König states that all forms and cases of tuberculosis of bones and joints are capable of spontaneous recovery with more or less loss of function; but it

may be stated as a general rule that the softer and more acute the tuberculosis, the larger the osteal foci, the earlier the suppuration and the less careful the early treatment, the more grave is the prognosis. An apparent recovery is always uncertain as to its duration, inasmuch as relapse or rekindling of the tuberculosis is likely to take place at any time. The articular tuberculosis usually extends over many years, especially the fungous pan-arthritis. The caries sicca may, according to König, come to an end in two or three years with some loss of mobility. Lighter forms of synovial tuberculosis or articular hydrops may disappear by proper treatment in a much shorter time.

As to the question when it can be said that recovery or disappearance of the tuberculosis has taken place, we may be guided by complete disappearance of the pain and swelling, and by the painlessness of what mobility has been left in the joint. As has been stated before, complete ankylosis is rare, but when it takes place it gives this advantage, that the pain disappears, even when the tuberculous foci are left in the capsule or the bones.

As to the prognosis in different ages, it may be said in general that children will more easily recover even from a severe articular tuberculosis than adults—a fact that permits of more extensive conservatism in the treatment of tuberculosis in early age. This is an important fact, as the articular ends, as is well known, play an important part in the growth of the extremities, and destructive operations in children are apt to leave useless limbs from lack of growth.

The danger to life from articular tuberculosis presents the following points for consideration :

1. Sepsis, a secondary invasion of the pus

microbes into the joint and peri-articular abscesses, is not uncommon. The pus microbes invade, not by auto-infection, but through careless or rather non-antiseptic treatment of spontaneous or artificial openings leading to peri-articular abscesses. It may thus be said that although practically this complication is not an uncommon one, it can be prevented by careful, systematic, antiseptic treatment. The difficulty is that the fistulous openings into tuberculous joints remain open for months and years, attendants and patients grow careless in course of time, and late septic invasion takes place.

2. General tuberculosis, acute or chronic, is much more grave, since it is impossible to prevent it. In the course of years a number of patients succumb to this complication. Billroth states that in sixteen years 27 per cent. were lost in this way. König, from a table of 117 operations for tuberculosis, found that after four years 16 per cent. had died from general tuberculosis.

3. It has recently been pointed out by various authors, especially König, Wartmann, and Albrecht that operations on tuberculous joints may cause immediate infection, the so-called operation tuberculosis. This complication is not very common; König in his extensive experience has seen only sixteen cases, and Wartmann, from a collection of excisions amounting to 837 cases with 225 deaths, found only twenty-six cases of operation tuberculosis. It sets in, as König describes it, seven to ten days after an operation, which may be aseptic and heal by first intention, either as acute tuberculosis of the lungs or tubercular meningitis, terminating in death three to four weeks after the operation. Sometimes in cases where the operation is followed by suppura-

ration and secondary operations become necessary, it follows these.

4. A number of patients in the course of years succumb to amyloid degeneration of the spleen, the liver and especially the kidneys, with its accompanying dropsy, which takes away some of the survivors.

I shall say nothing as to the treatment of the articular tuberculosis, inasmuch as this question belongs to special surgery, and would be altogether too extensive to be taken up in the time allotted by this Society to the discussion of the question of tuberculosis.

However, before leaving the field of tuberculosis I want to call the attention of the Society to a comparatively rare localization of the tubercle bacillus, and to an affection that has only been recently recognized as such, namely,

TENDON TUBERCULOSIS.

Tendon tuberculosis is a necessary appendix of tuberculosis of the joints. I do not mean tuberculosis of the tendons where the tuberculosis creeps out along the tendons from a tuberculous joint, as you find it around the tendo Achillis from the ankle joint, or the flexor tendons of the arm from a tuberculous wrist-joint; but I mean primary tendon tuberculosis, which is on an equal footing with any other primary synovial tuberculosis. The subject of tendon tuberculosis is a new one. French authors more than thirty years ago called attention to a so-called fungous tendon synovitis, describing it, as far as gross appearances go, very well, but of course they did not come to an understanding about its pathology any more than about that of the so-called synovitis of the joints. Nothing was done

until 1875 when Volkmann¹ gave a masterly description of the tendon tuberculosis, but without recognizing it as a tuberculosis. Then came Riedel, König's assistant, who showed that the rice bodies so commonly found in the so-called fibrinous hydrops of the tendon sheaths, or hygromas of the flexor tendons of the hand always indicate a synovial tuberculosis.

I wish only to say a few words about the pathology of this form of tuberculosis, because as far as it needs treatment, it is a synovial tuberculosis—a fungous synovitis. It is a tuberculosis with an enormous development of tuberculous tissue in the sheath of the tendon and on the tendon itself. In the sheath of the tendon it forms a layer of from one to four lines in thickness, of the usual well-known gelatinous tuberculous tissue. On the tendon it forms a similar layer usually smaller and with that important anatomical feature that this granulation tissue creeps down between the bundles of the tendon and separates them until finally it makes a perfect brush out of them; then atrophy of these separate bundles of the tendon takes place and the tendon ruptures—a spontaneous rupture in the same sense as a spontaneous fracture, that is, that with a very slight movement the tendon tears. If left alone this tendon tuberculosis has the same fate as tuberculosis of the same character in other parts of the body; it goes on to liquefaction of the tubercles and the surrounding tissue, and pus, if we may so call it, tuberculous pus without the pus microbes, forms. This abscess is opened or breaks spontaneously, leaving tuberculous fistulæ with no tendency to heal, just the same as fistulæ leading into tuberculous joints. The same fate, as with all other tuberculous tissue, will be

¹Beiträge zur Chirurgie.

the result of the opening, namely, that if septic invasion from without takes place, that is, if the tuberculosis is not removed at that time, or anti-septic precautions taken, then sepsis sets in and finds a congenial soil in the tuberculous tissue, an excellent culture soil for the common pus microbe; just the same as in tuberculous abscess from Pott's disease, or tuberculosis of the vertebral column, in which the opening is, in the large majority of cases, the beginning of the end. Tendon tuberculosis most commonly attacks the flexor tendons of the hand; then we have the so-called hygroma of the hand with its swelling in the palm and above. These are undoubtedly always tuberculous; further we find isolated tendon tuberculosis in the extensor tendons of the hand, more rarely in the tendons of the lower extremity, as the patellar ligaments, of which I have seen one case.

I wish to present a patient to-night who has kindly consented to come down and show his hand. The history is as follows:

John Harrington, laborer, aged 35. Family history good. The present trouble commenced about three years ago when the patient noticed a slight painless swelling on the dorsum of his hand. A watery fluid collected which was removed but collected again; the increased swelling gave rise to severe pain and inability to flex the fingers. After a few months the swelling broke spontaneously, and there was a sero-purulent discharge. This discharge continued for about two years, the swelling increasing slightly, until October 27, 1888, when the patient came to my clinic at the College of Physicians and Surgeons.

Examination revealed a swelling about five inches long in the median line of the dorsum of

the hand extending from about one and one-half inches from the metacarpo-phalangeal articulation to beyond the wrist-joint.

Diagnosis: Tendon tuberculosis of the extensor tendons of the hand. An incision was made extending from within half an inch of the metacarpo-phalangeal articulation, seven inches up the forearm in the median line, over the swelling. The incision was made down to the muscles and tendons and a quantity of rice bodies removed; these were also found inclosed in the sheaths of each of the tendons when opened. The sheaths of the extensor tendons were removed and each and every tendon was thoroughly scraped to remove the tuberculous material. The extensor tendon of the thumb was divided, it being impossible to separate the tuberculous tissue without this. The tendon was united to one of the other extensor tendons. The integument was sutured with silk and the hand and forearm dressed antiseptically. One week after the operation the wound had united, and the sutures were removed and the hand dressed. Two weeks after the operation there was good union. Four weeks after the operation flexion and extension of the fingers was regained. There was no sign of return of the disease.

When this man came for operation, one of the tendons, the short extensor of the thumb, was destroyed; the others could be separated from the tuberculous tissue. This dissection of the tendons from the tuberculous tissue takes a long time. It has to be done with the utmost care because the tuberculous tissue that runs down between the fibres of the tendons is adherent; there is no short way of rubbing it off the tendons, it must be dissected off carefully, particle by particle, and then the whole sheath of the tendon

dissected off with scissors and forceps, just as carefully as in the joints, particle by particle, and this law holds good in all operations for tuberculosis. Then come the difficulties of dressing. It has been found that in dressing with drainage tubes, antiseptic washes, etc., the results are not as good as if the wound is left to heal by the organization of an aseptic clot, as Lister called it. But this healing without drainage implies that the wound shall be filled with blood. No exact union of the wound is made, but a couple of spaces are left between the sutures so that the surface blood can get out. Schede recommends this method, having found that the connective tissue formed in the nidus of the clot was more pliant than the connective tissue formed when there was drainage. That method was used in this case, and the consequence is that much more extension than before is possible. This patient also shows a tuberculosis of a metacarpo-phalangeal joint.

The prognosis as to the future functions of the tendons depends upon perfect asepsis (if there is not perfect asepsis then the result is lost); sup-puration must not take place after the operation. It further makes a great difference as to the future function of the hand whether the tuberculosis is on the dorsal or on the palmar side. On the palmar side of the hand where we have to open from the palm up to the middle of the forearm, the palmar ligament may be divided and re-united with sutures, and it may be necessary to do this so as to dissect out the wall of the common tendon sheath. Tuberculosis in the palm of the hand gives much less satisfactory results after operation for removal of the tuberculous sheath from the tendon, than on the dorsal side of the hand. Another point is that when the

tuberculosis has reached the upper end of the tendons it creeps up the muscles not only in the loose connective tissue, but up between the bundles of the muscular fibers. This we can recognize with the naked eye by the color and consistency of the muscle. The invaded muscle becomes hard and grayish and is not shining as the normal muscle tissue. Of course all this tissue has to be cut away carefully, because it is one of the modern improvements of our technique in operating for tuberculosis that every part of the diseased tissue is carefully removed from the joints by scissors and forceps, so as to leave, if possible, no tuberculous tissue at all. This makes a very different operation from the one where the bones are sawed off from the joints, for instance, and the abscess drained, no care being taken either of the walls of the abscess or the cartilage, the consequence being that the tuberculosis very often grows right out again and there is greater liability to sepsis setting in. These operations are long and tedious, but if perfect asepsis is secured we may expect the results to be locally permanent. Tendon tuberculosis is a rare disease; it exists only in 1 or 2 per cent. of the cases in the statistics of tuberculosis.

